

# RAND Research Brief

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## China's Commercial Technology Implications for Future Military Capabilities

If China's economy continues to grow as expected over the next 20 years, by 2020 it will surpass that of the United States in terms of purchasing power. Such growth would in theory provide China with the economic base to field a military comparable to that of the United States. But in order to become a true military superpower, China would need to make major improvements in the technological capabilities of its defense industries. One potential source of such improvement could lie in China's civilian industries, many of which currently enjoy unprecedented levels of foreign technology and investment.

In *The Military Potential of China's Commercial Technology*, RAND researcher Roger Cliff investigates the degree to which China's commercial sector could contribute to improved military technology over the next 20 years. The study finds that, while China is likely to narrow the technology gap by 2020, average civilian and military technological levels in China should be expected to remain significantly behind those of the United States and Japan. This failure to "catch up" does not mean that China cannot present a serious military challenge to the United States, however. U.S. policymakers must prepare to address a China whose military technologies continue to advance steadily and one likely to develop strong military capabilities in "niche" areas.

### CHINA'S CURRENT TECHNOLOGICAL CAPABILITIES LAG BEHIND WORLD STANDARDS

The study examines the current capabilities of eight major civilian industries with the potential to support military development: microelectronics, computers, telecommunications, nuclear power, biotechnology, chemical technology, aviation, and space. Among the study's major findings:

**China currently has significant production capabilities in all eight areas, and in some of them has facilities that are quite advanced.** China's capabilities in producing telecommunications switching systems, fiber-optic cable,

and low-end personal computers are comparable to those of advanced industrial nations. China has more than 28,000 chemical-producing enterprises and possesses considerable growth potential in biotechnology. China's space launch capability is impressive for a developing country, and China has a manned space program that aims to put astronauts in space by 2002.

**Despite these successes, China has typically failed to capture the critical technologies associated with these industries, and, as a result, remains largely dependent on imported components and machinery.** For example, China lacks the capability to manufacture the lithography tools used to make integrated circuits necessary for microelectronics. China's nuclear facilities have also typically relied on imports for most of their key components. China's aircraft are mostly based on 1950s and 1960s Soviet technology, and China's ability to produce transport aircraft is limited to short-range and medium-range turboprops.

**On average, China's technological capabilities are well below world standards.** Mediocre or poor performance is typical of many Chinese industries. Manufacturing operations in general tend to be inefficient, while the overall level of computerization in industry is low. China is limited in its ability to produce communications and other types of satellites. Telecommunications firms lack the capability to produce sophisticated terminal node equipment such as cellular phones.

**Although China possesses strong basic research capabilities in several areas, it has frequently been unable to translate these successes into improved production technologies.** Biotechnology provides a case in point. Despite strong research capabilities, China's commercial biotechnology sector remains small, and future growth in this industry could be impeded by limited production technologies and weak protections for patents. China's software capabilities are just beginning to develop, and piracy remains a major deterrent to domestic soft-

ware development. Even China's huge chemical industry has typically been unable to turn research results into commercial products, leaving the country dependent on imports for many chemicals.

## **CHINA'S PROSPECTS FOR FUTURE TECHNOLOGICAL PROGRESS ARE MIXED**

The study assesses China's potential for acquiring or developing new technologies in terms of the capabilities provided by facilities, equipment, and human resources; efforts to employ these capabilities to develop new technologies; economic and other incentives; and legal, industrial, and technology institutions.

On the whole, China's prospects for technological progress were found to be mixed. China's physical and human capabilities are substantial but insufficiently developed. The equipment found in most Chinese research and development facilities does not meet world standards, while those few facilities that possess advanced equipment do not use it to its full potential. China has a solid educational base for a developing country, but secondary and higher education rates compare poorly with those of more developed countries such as South Korea and Taiwan, and even worse with those of the United States and Japan. The huge size of China's population means that, in absolute terms, China possesses a much larger human capital base for research and development than does South Korea or Taiwan, but the equally huge size of China's workforce means that a greater proportion of scientists and engineers are required for routine production activities. China's technological efforts have also been limited. As a proportion of the total labor force, the number of scientists in China who are engaged in research and development is much lower than that of Taiwan or South Korea, although China surpasses these countries (although not the United States or Japan) in terms of overall research and development expenditures. China's output of scientific and technical publications is much lower than that of the United States and Japan, but significantly greater than that of South Korea and Taiwan.

China's incentive and institutional structures are imperfectly developed. High domestic growth rates and

relatively stable exchange rates have tended to encourage innovation. At the same time, uncertainty about the economy, fluctuating inflation rates, limited access to credit and foreign exchange, and periodic instances of political instability have tended to discourage investment in technology. Competition also provides mixed incentives, with many industries overly protected and others subject to excessive fragmentation. Capital markets generally provide poor incentives for innovation, and most bank loans are directed toward government industry, the least technologically dynamic sector. Technology markets are also underdeveloped, although labor markets operate fairly well. China's institutional structures for technological progress, particularly the legal system, are inadequate.

## **U.S. DEFENSE PLANNERS MUST PREPARE FOR A CHINESE MILITARY THAT IS INCREASINGLY SOPHISTICATED**

The study concludes that, while Chinese technological capabilities will not catch up to, much less surpass, those of the United States or Japan at any time in the foreseeable future, it is plausible that, by 2020, average technological levels in China might be roughly comparable to those in Taiwan and South Korea today. Moreover, a combination of foreign technology transfer and domestic research efforts could begin to make available to China's defense industries technologies that are close to those available to U.S. defense industries in some areas. Nonetheless, the process of translating civilian technological capabilities into military technology will be challenging for China.

While China's overall military technology in 2020 can be expected to be significantly inferior to that of the United States, China is likely to develop niche capabilities in certain military technologies. Such capabilities could provide it with a local advantage under certain military scenarios, especially those that would require the U.S. military to operate far from home. U.S. defense planners must prepare for the possibility of conflict with a Chinese military that is increasingly sophisticated, and they should continue to monitor closely China's research and development efforts in order to detect and respond to any particular threats.

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*RAND research briefs summarize research that has been more fully documented elsewhere. This research brief describes work done for RAND's Project AIR FORCE; it is documented in The Military Potential of China's Commercial Technology, by Roger Cliff, MR-1292-AF, 2001, 94 pp., ISBN 0-8330-2939-8, available from RAND Distribution Services (Telephone: 310-451-7002; toll free 877-584-8642; FAX: 310-451-6915; or E-mail: order@rand.org). Abstracts of all RAND documents may be viewed on the World Wide Web (<http://www.rand.org>). Publications are distributed to the trade by NBN. RAND® is a registered trademark. RAND is a nonprofit institution that helps improve policy and decisionmaking through research and analysis; its publications do not necessarily reflect the opinions or policies of its research sponsors.*

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